ERITECH®

# Electric Utility Application and Reference Guide

Asia

ERICO®

Power Generation 3

Substation Earthing/Grounding
Lightning Protection 4 – 5

Power Transmission
and Distribution 6 – 7

Accessories for Electrical
Utility Applications 8 – 9

Design Assistance 10

Earth/Ground Test Equipment 10

Applicable Standards 11

## Facility Electrical Protection

ERICO offers a full range of ERITECH® Facility Electrical Protection products designed to protect power utility facilities worldwide. ERICO's product offerings include ERITECH® grounding and bonding accessories, surge and lightning protection products and CADWELD® welded electrical connections.

## Earthing/Grounding and Bonding

ERITECH offers an extensive line of grounding and bonding products, which includes ground rods, theft deterrent conductors, mechanical clamps, compression and threaded couplers, chemical ground rods, GEM (Ground Enhancement Material), inspection wells, grounding plates, prefabricated ground mesh and ground test instruments.

## CADWELD® Welded Electrical Connections

CADWELD welded electrical connections are used to connect the grounding and bonding conductors to the ground electrode system, including ground rod electrodes, building steel and rebar. CADWELD connections provide a permanent, low-resistance connection needed to create a long-lasting, reliable bonding network with long service life.

CADWELD connections will not deteriorate or loosen with time and are made with affordable, lightweight and portable equipment.

## Surge Protection

Surge protection products are designed to help protect against damaging electrical surges on power and communications lines caused by lightning and other switching events. With the increasing focus on system reliability and the Smart Grid initiatives underway in many countries, surge protection is more critical than ever based on the amount of electronics control and monitoring systems on the power grid today.

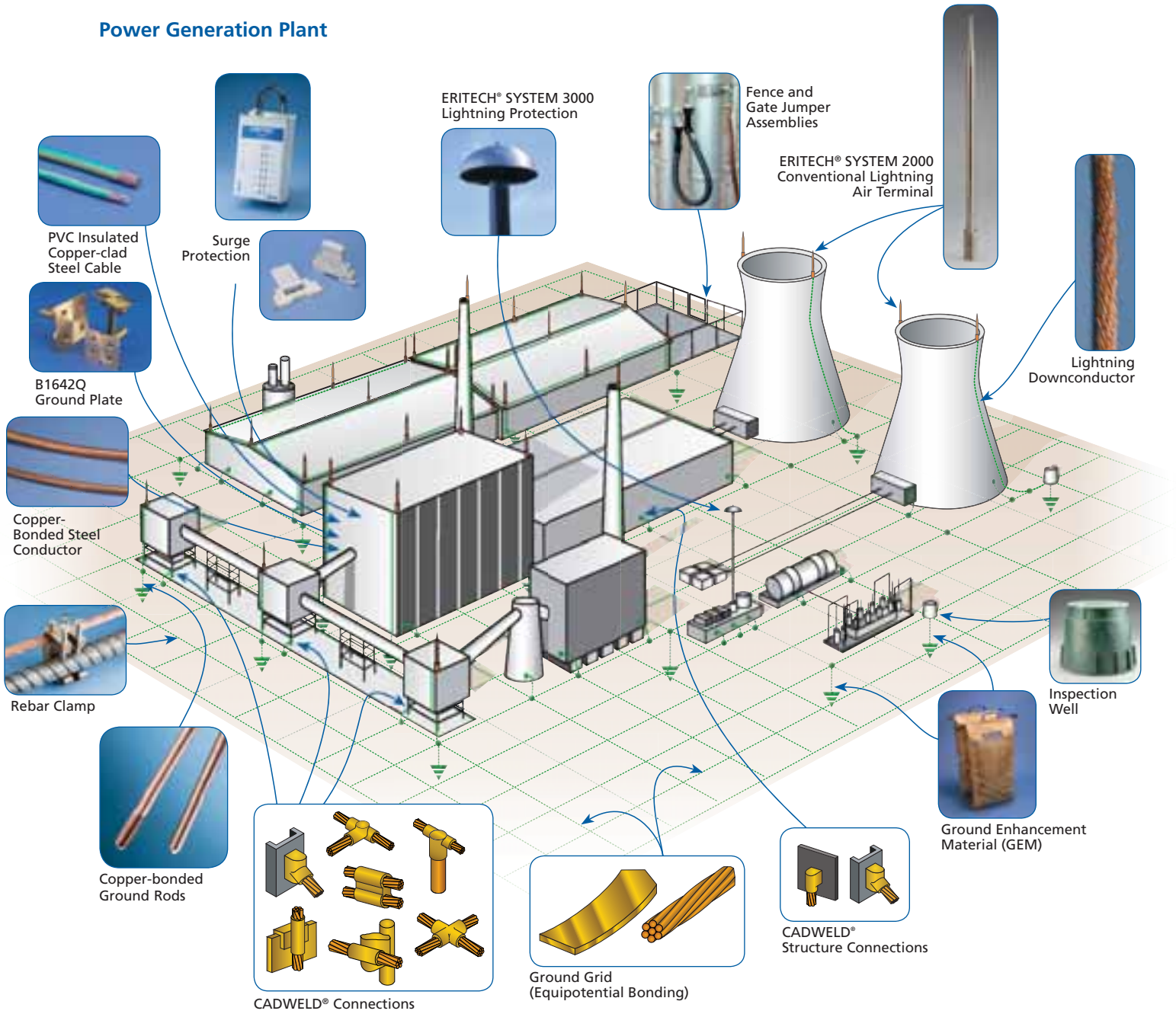
## Lightning Protection Systems

Direct and indirect lightning strikes can pose many risks to businesses, including damaging buildings and critical equipment. ERITECH lightning protection products offer a variety of solutions to help protect valuable equipment and personnel and to help prevent service disruption and downtime.

## Power Generation Facilities

Traditional power generation facilities have either been coal-fired, gas-fired, nuclear, diesel or hydro-powered. Modern alternative power generation facilities can include geothermal, bio-gas, wind or solar. ERITECH® brand of lightning protection systems have been used to provide lightning protection to the whole host of facilities in a unique manner. ERITECH grounding and bonding solutions can provide a complete system for the grounding and bonding of any of these facilities.

### Power Generation Plant



## Substation Earthing/Grounding and Lightning Protection

The conceptual design of a ground grid at a substation is summarized by the points below and depicted on pages 4 and 5.

a) A continuous loop conductor should surround the perimeter to enclose as much area as practical. Under Standard IEEE® 80, this loop conductor is placed 3 ft (or 1 meter) outside the fence line. This measure helps to avoid high current concentration and high gradients both in the grid area and near the projecting cable ends. Enclosing more area also reduces the resistance of the grounding grid.

b) Within the substation, conductors are typically laid in a parallel grid and, where practical, along the structures or rows of equipment to provide for short ground connections.

c) A typical grid system for a substation may include bare copper conductors buried 18" (31"(0.8 m))(0.5 m) (copper-bonded steel cable or copper-clad steel cable) below grade, spaced 9 ft to 21 ft (3 m to 7 m) apart, in a grid pattern.

At cross-connections, the conductors would be securely bonded together. Ground rods may be at the grid corners and at junction points along the perimeter.

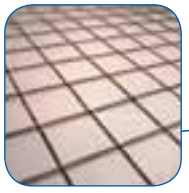
d) This grid system would be extended over the entire substation switchyard and beyond the fence line.

## Earth/Ground Rods

ERICO offers a range of ground rods to suit the needs and preferences of the utilities. The most common of these are copper-bonded steel rods, due to their versatility in varied soil conditions and compatibility with various common metals used underground. The copper-bonded ground rod has an electrolytic coating of copper deposited over a layer of nickel. This process helps ensure a long-lasting molecular bond between the copper layer and the steel core. ERICO recommends ERITECH® brand of copper-bonded ground rods because the copper coating will not slip or tear when driven, nor will it crack if the rod is bent. The tough, carbon steel core has good characteristics for deep driving. Copper-bonded ground rods have a high resistance to corrosion and provide a low-resistance path to ground.

It is important to note that certain soils and landfill areas may not be compatible with copper. In these situations, stainless steel is a better choice. The ERITECH brand of copper-bonded ground rods comply with UL® 467, BS:7430 & EN50164, Standards.

Surge Protection

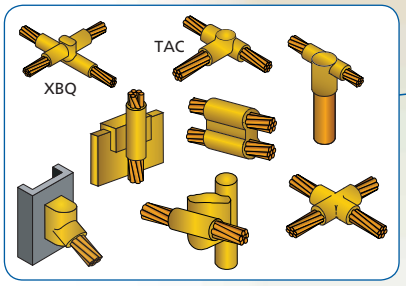


Prefabricated Wire Mesh

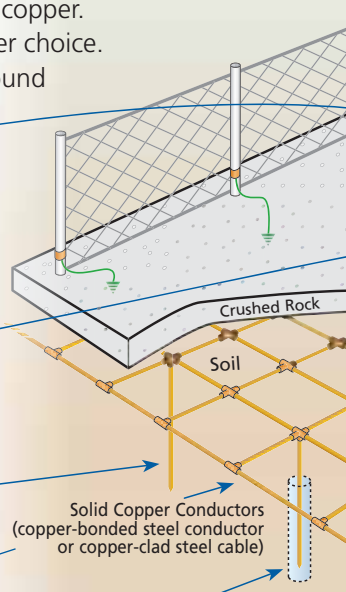
Copper-bonded Rods

Copper-bonded Steel Conductor

Ground Enhancement Material (GEM)



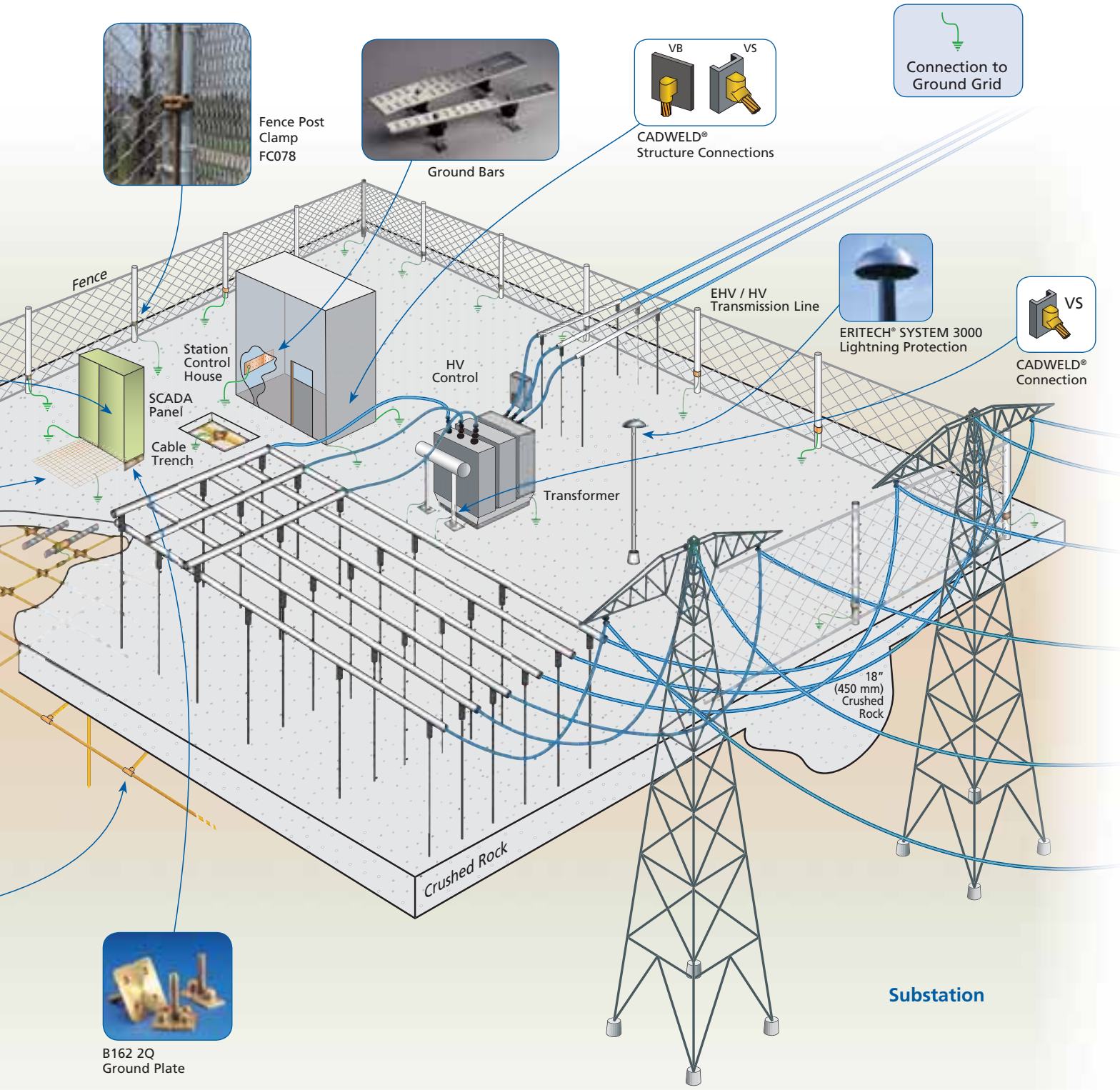

CADWELD® Connections



## Surge Protection for SCADA-controlled Equipment

Electronic equipment operating within a substation environment is particularly subject to electrical disturbances such as switching, electrical noise, ground potential rise and occasional induced or direct lightning impulse. Surge protection is an extremely cost-effective investment for electronic substation equipment, because:

- Each site's operation is critical to the quality supply of electrical power
- Downtime costs are significant



## Power Transmission and Distribution

The grounding of facilities associated with the distribution of power is sometimes not given the same level of thought and design scrutiny as is given to the substations. ERICO has a complete range of products that address this need.

## Earthing/Grounding Connections

Grounding connections are vital to the proper operation and integrity of the electrical system. ERICO offers a range of mechanical connections, including clamps, jumpers, fence connections, U-Bolts and other clamps. ERICO recommends the CADWELD® welded electrical connection for making these connections. The principle technology consists of bringing together a welding material and ignition agent in a graphite mold. The reduction of copper oxide by aluminum produces molten copper and aluminum oxide slag at extremely high temperatures. The shape of the mold, its dimensions and the size of welding material are all dependent on the items to be welded. This results in a molecular bond that exceeds the life of the conductor.

## GEM

Ground Enhancement Material (GEM) is a superior conductive material that improves grounding effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils). GEM can dramatically lower earth resistance and impedance measures. Once in its set form, it maintains constant resistance for the life of the system. GEM performs in all soil conditions, even during dry spells and it does not dissolve, decompose or leach out with time.

## Copper-bonded steel conductor

ERICO offers several solutions for buried conductors in a ground grid.

The copper-bonded steel conductor (CBSC) is comprised of an electrolytic coating of copper deposited over a thin layer of nickel. This process helps ensure a long-lasting, molecular bond between the copper layer and the steel core. The conductor consist of low-grade carbon steel with high mechanical performance. The CBSC provides high conductivity and corrosion-resistance properties. The unique properties of CBSC make it ideal for use as either a horizontal grounding conductor below grade in all grounding application systems or a lightning protection conductor.

As an option, ERICO has a range of stranded copper-clad steel cables that can also be used as grounding conductors.

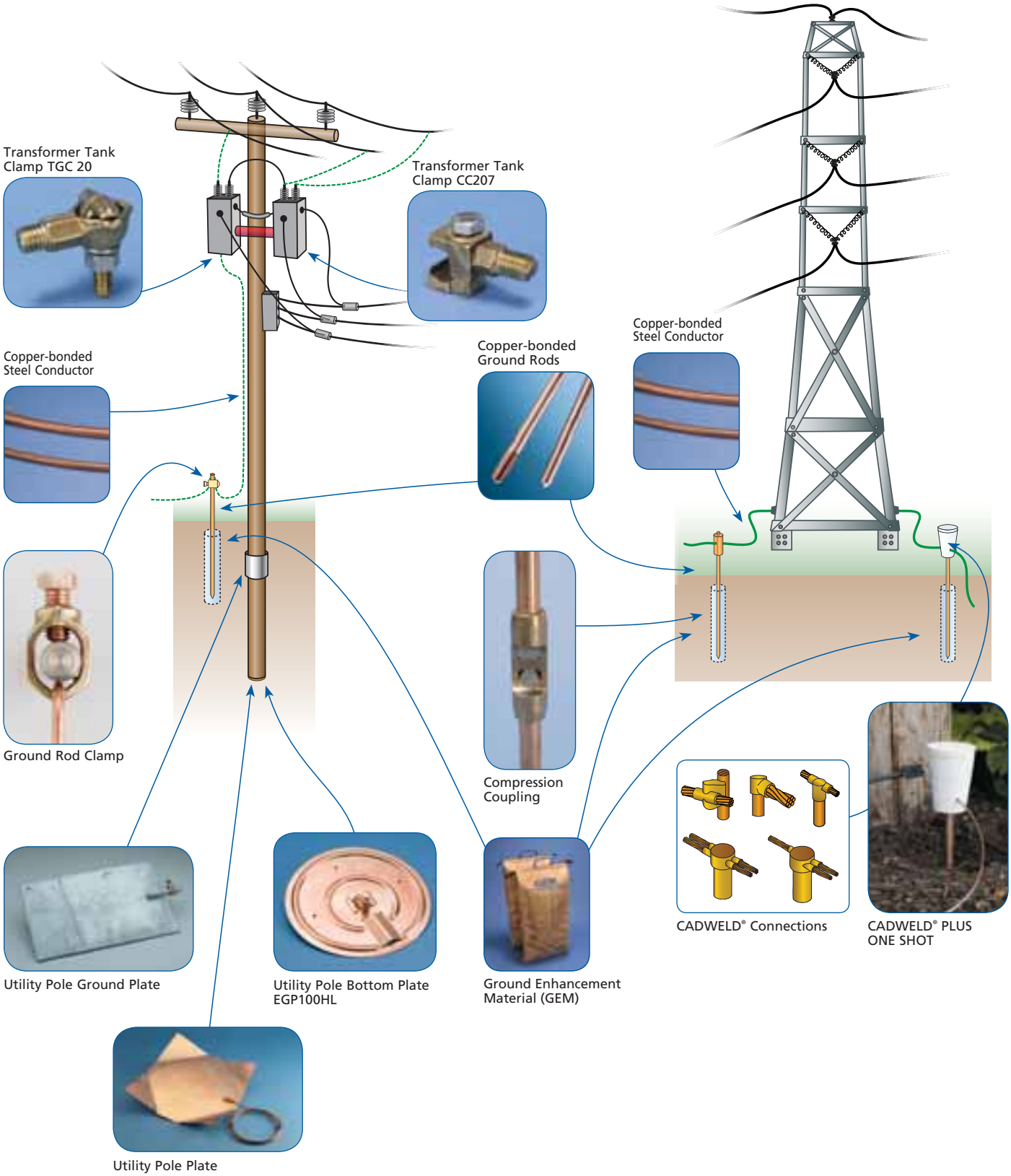
CADWELD is the most suitable connection method for all of these specialized conductors.

## Surge Protection for Transmission and Distribution

Electronic equipment operating at remote system monitoring locations on distribution lines are susceptible to ground potential rises and induced or direct lightning impulses on the network. Surge protection is an extremely cost-effective investment for such equipment as this equipment is most needed during times of local storm activity. Therefore protection that is robust against high level surge activity, and protection that is immune to voltage fluctuation on the network is critical.

## Distribution Pole

## Transmission Tower



# Accessories for Electrical Utility Applications

Along with our main systems and components for the utility industry, ERICO offers a wide range of accessories to assist in grounding, bonding and lightning protection needs.

## Ground Rods and Ground Rod Couplers

Complete range of earth/ground rods, and couplers, including copper bonded rods of various size and specification. For complete range and details please refer to the ERITECH® Ground Product catalog.

## CADWELD®

Complete range of CADWELD® applications for permanent connections from wire to rod, or wire to wire, etc. For complete range and details please refer to the CADWELD Electrical Connections catalog.

## CADWELD® ONE SHOT

Complete range of CADWELD® ONE SHOT applications for permanent connections from wire to rod, or wire to wire. For complete range and details please refer to the CADWELD Electrical connections catalog.

## Ground Rod Clamps

CP Series

HDC Series

SP Series

| Part No. | Rod Diameter (in) | Conductor Range (AWG) |
|---|---|---|
| HDC58* | 5/8 | 8 solid - 1/0 stranded |
| HDC58R* | 5/8 | 8 solid - 1/0 stranded |
| HDC34 | 3/4 | 8 solid - 1/0 stranded |
| HDC34SP | 3/4 | 8 solid - 3/0 stranded |
| CP58 | 5/8 | 10 solid - 2 stranded |
| CP34 | 3/4 | 10 solid - 1/0 stranded |
| SP58 | 1/2, 5/8 | 10 solid - 2 stranded |
| SP58B916** | 1/2, 5/9 | 11 solid - 2 stranded |

* HDC58 threads are 1/2" - 13 UNC. HDC58R threads are 7/16" - 14 UNC.
** SP58B916 is stainless steel and has a 9/16" bolt head.

## Copper-bonded Steel Conductor

| Part No. | Ø mm | Description |
|---|---|---|
| CBSC8 | 8 | Std packaging 100m |
| CBSC10 | 10 | Std packaging 100m |
| CBSC13 | 13.2 | Std packaging 100m |
| CBSC14 | 14.2 | Std packaging 100m |
| CBSC16 | 15.6 | Std packaging 100m |
| CBSC18 | 17.6 | Std packaging 100m |

## Copper-clad Steel Conductors

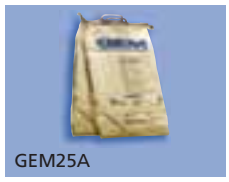
| Part No. | Cross-Section area | PVC Insulated Type |
|---|---|---|
| 30CCS16 | 16 $mm^2$ | 30CCSIN15 |
| 30CCS25 | 25 $mm^2$ | 30CCSIN25 |
| 30CCS35 | 35 $mm^2$ | 30CCS35 |
| 30CCS50 | 50 $mm^2$ | |
| 30CCS70 | 70 $mm^2$ | 30CCS70 |
| 30CCS95 | 95 $mm^2$ | 30CCS95 |
| 30CCS120 | 120 $mm^2$ | |
| 30CCS150 | 150 $mm^2$ | |
| 30CCS185 | 185 $mm^2$ | |
| 30CCS240 | 240 $mm^2$ | |
| 30CCS300 | 300 $mm^2$ | |

## Utility Grounding Bars

EGB Series

Various material, coating and configurations – contact ERICO for your specific needs.

## Ground Enhancement Material (GEM)



GEM25A

GEM25ABKT

GEM25A: 25 lb (11.36 kg) bag of GEM

GEM25ABKT: 25 lb (11.36 kg) bucket of GEM

Technical support is available to help estimate the quantity of GEM needed for any installation – contact ERICO for your specific needs.

# Accessories for Electrical Utility Applications

## Inspection wells


PIT03


PIT05

| Part No. | Description |
|---|---|
| PIT05 | Polymer inspection well 12″ X 12″ X 8.5″ deep |
| PIT03 | Polymer inspection well 6″ X 8.5″ X 8.5″ deep |
| T416A | Polymer inspection well 14" X 23″ X 18" deep |
| T416B | High density polyethylene inspection well 10" round X 10" deep |
| T416C | High density polyethylene inspection well 14" round X 18" deep |
| T416D | Polymer inspection well 13" X 13″ X 12" deep |
| T416E | Polymer inspection well 13" X 13″ X 18" deep |
| T416F | Polymer inspection well 13" X 13″ X 26" deep |

## Ground Plates

| Part No. | Description |
|---|---|
| B1612Q | 4-hole, 4/0 concentric |
| B1613Q | 4-hole, 500 concentric |
| B1622Q | 2-hole, 4/0 concentric |
| B1642Q | 4-hole, 4/0 concentric |
| B1643Q | 4-hole, 500 concentric |

## Ground Plate Electrodes


EGGPC


EGP100


EGP100HL

| Part No. | Description |
|---|---|
| UGP719 | Utility ground plate 7.5" X 19.25" |
| UGP738 | Utility ground plate 7.5" X 38.5" |
| EGGP | Galvanized steel ground plate, without connector |
| EGGPC | Galvanized steel ground plate, with HDC58R connector |
| EGP100 | Copper utility pole bottom plate with cable lug |
| EGP100HL | Copper utility pole bottom plate with ERITECH® HAMMERLOCK connector |

## Transformer Tank and Vice Clamps


TGC 2/0


VC Series

| Part No. | Conductor Range (AWG) | Stud Thread Size |
|---|---|---|
| TGC2/0 | 10 solid - 2/0 stranded | 1/2″ - 13 |
| CC207 | 6 solid - 1/0 stranded | |
| VC62 | 6 solid - 2 stranded | |
| VC220 | 2 solid - 2/0 stranded | |

## Split Bolts


Bronze Series


Tinned Bronze Series

ESB Series

See ERITECH® Grounding Catalog for complete range of copper or tinned copper split bolts

## Fence Post Clamps

| Part No. | Pipe Size (Imperial) | Conductor Range (AWG) | Pipe Size (Metric) | Conductor Range (Metric) |
|---|---|---|---|---|
| FC073 | 1-1/2″ | 4 Sol - 2/0 Str | 40.0 mm | 16.0 $mm^2$ Str - 70.0 $mm^2$ Str |
| FC074 | 1-1/2″ | 2 Sol - 250 MCM Str | 40.0 mm | 50.0 $mm^2$ Str - 120.0 $mm^2$ Str |
| FC075 | 2″ | 4 Sol - 2/0 Str | 50.0 mm | 16.0 $mm^2$ Str - 70.0 $mm^2$ Str |
| FC076 | 2″ | 2 Sol - 250 MCM Str | 50.0 mm | 50.0 $mm^2$ Str - 120.0 $mm^2$ Str |
| FC078 | 2-1/2″ | 4 Sol - 250 MCM Str | 65.0 mm | 16.0 $mm^2$ Str - 120.0 $mm^2$ Str |
| FC079 | 3″ | 4 Sol - 2/0 Str | 80.0 mm | 16.0 $mm^2$ Str - 70.0 $mm^2$ Str |
| FC080 | 3″ | 2 Sol - 250 MCM Str | 80.0 mm | 50.0 $mm^2$ Str - 120.0 $mm^2$ Str |
| FC082 | 3-1/2″ | 4 Sol - 2/0 Str | 90.0 mm | 16.0 $mm^2$ Str - 120.0 $mm^2$ Str |

## Rebar Clamps


EK Series

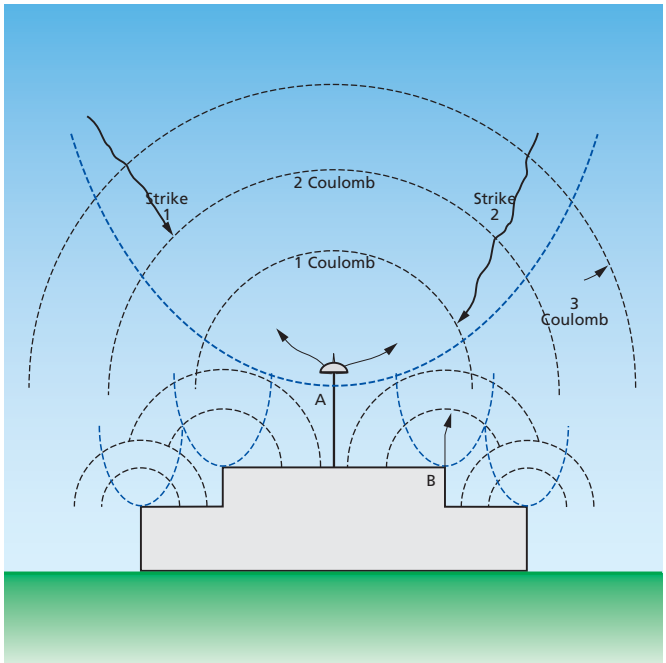

RC Series

| Part No. | Conductor Range (AWG) | Conductor Range (Metric) | Rebar Size (imperial) | Rebar Size (Metric) |
|---|---|---|---|---|
| EK16 | 8 solid - 2/0 stranded | 10 - 70 $mm^2$ | #3 - #6 | 8 - 18 mm |
| EK17 | 8 solid - 4/0 stranded | 10 - 100 $mm^2$ | #6 - #11 | 18 - 36 mm |
| RC70 | 8 solid - 2/0 stranded | 10 - 70 $mm^2$ | #3 - #6 | 8 - 18 mm |
| RC100 | 8 solid - 4/0 stranded | 10 - 100 $mm^2$ | #6 - #11 | 18 - 36 mm |

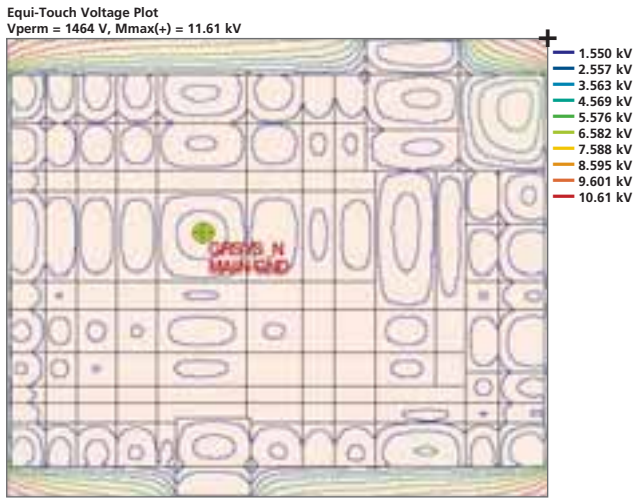
# Design Assistance

ERICO provides a high level of application engineering and design assistance to the users of its products. A dedicated team within ERICO engineering can solve grounding application problems. This team carries out modeling of a lightning protection system using modern software tools that use complex algorithms to model lightning strikes in a more accurate way than traditional methods.

ERICO offers a set of drawings of details using our products that can be used in the customers' construction documentation. Software is available for public use that will assist with the selection of CADWELD® connections and the design of grounding systems using GEM.




**Lightning Protection Modelling**




**Computer Analysis of Substation Earthing/Grounding**

## Earth/Ground Test Equipment

To complete the range of grounding products, ERICO offers modern ground testing equipment that is suitable for performing soil resistivity measurements, step-and-touch voltage measurements, ground resistance measurements and stakeless clamp-on ground testing.

**Earth/Ground Testers**

# Applicable Standards for Design of Earthing/Grounding Systems

### USA, Australia, Asia

The IEEE® earthing/grounding and lightning protection standards in the U.S. are used quite commonly around the world, especially in Asia and Australia.

The IEEE 80 Standard for Safety in AC Substation Grounding is the most common document used to assist with the design of a system. Many countries have guides written either by power utilities, industry associations or standards to complement IEEE standards. The IEEE 80 Standard requires connections that are used in substations to pass all the tests stipulated in IEEE 837 as verified by independent reports.

CADWELD® welded connections have been shown to pass all of the tests sequences in IEEE 837 in comprehensive tests carried out by independent test labs. In the same set of experiments, it was demonstrated that mechanical connectors that are sometimes used in substation applications do not pass the tests outlined in Standard IEEE 837.

Other standards that are relevant to grounding and lightning protection include the IEEE 81- IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System and IEEE Std 998 Guide for Direct Lightning Strike Shielding of Substations.

The UL© SPEC 467 Grounding and Bonding Equipment provides a comprehensive compliance and testing method to ensure long and reliable life of an earth/ground rod.

### Europe

Most major power utilities in Europe have their own internal standards and regulations for the grounding of substations and the designer should refer to them for guidance. Additionally, the IEEE 80 Standard (as well as the standards related to it) is also widely used since it provides a fully integrated approach to the design of an efficient earthing system. The IEC® 60479-1 Standard contains formula for the calculation of step-and-touch potentials but does not cover all the resistivity and system resistance aspects or fault current-related calculations covered in IEEE 80.

The EN62305-3 Standard regarding lightning protection of buildings gives directions about earthing/grounding of lightning protection systems, as well as some simple rules regarding step-and-touch potentials, which have to be used with care when applied to power utility installations.

The BSEN50164-2:2002, Requirements for Conductors and Earth Electrodes, is a standard used as a reference for testing of ground rods.

### China

DLT621-Grounding for AC electrical installation is an application guide for grounding in power utilities. It references IEEE80.

The GB50057-2010:Code for the protection of structures from lightning is a recently issued compulsory Chinese National standard, which includes commercial industry structures, petrochemical, commercial, railway stations, etc. The new code allows the use of the copper-bonded conductor for grounding and lightning protection conductor. The CADWELD connection is also allowed as a connection method for buried conductors in the grounding system.

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